

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

– Utility Patent Specification –

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Invention:

**PREFORMED PORTABLE SLAB FOR USE AS A FOUNDATION OR
SPLASH PAD FOR INDUSTRIAL EQUIPMENT**

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(Docket No.: AirLiquide-055;S-6375)

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[Printed: January 29, 2004]

**PREFORMED PORTABLE SLAB FOR USE AS A FOUNDATION OR SPASH PAD
FOR INDUSTRIAL EQUIPMENT**

RELATED APPLICATIONS

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This application claims priority from United States Provisional Application number 60/503,961 filed on September 19, 2003.

TECHNICAL FIELD

The present invention relates to portable pads or slabs, particularly to portable precast 10 slabs for use as temporary, removable, or permanent foundations for industrial equipment, bulk storage tanks, cryogenic liquid pumps, and the like, and related methods of making and using the slab. It is also suitable as a protective surface, for example as an off loading or splash pad for liquid oxygen, or liquid hydrogen, or other cryogenic liquids.

DESCRIPTION OF THE DRAWINGS

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FIG. 1 is a perspective view of one embodiment of the invention.

FIG. 2 is a view of a reinforcing means of an embodiment of the invention.

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FIG. 3 is a side view of an attachment means of an embodiment of the invention.

FIG. 4 is a side view of an attachment means of an embodiment of the invention.

FIG. 5 is a top view of an embodiment of the invention.

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FIG. 6 is a cross-sectional side view of an embodiment of the invention.

FIG. 7A is a cross-sectional side lengthwise view of an embodiment of the invention.

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FIG. 7B is a cross-sectional side endwise view of an embodiment of the invention.

FIG. 7C is a side view of an attachment means of an embodiment of the invention.

FIG. 8 is a side view of an attachment means of an alternate embodiment of the invention.

5 DETAILED DESCRIPTION

For purposes of the description of this invention, the terms "upper," "lower," "left," "vertical," "horizontal," "top," "bottom," "lower," "side," and other related terms shall be defined in relation to embodiments of the present invention as described herein and as 10 illustrated in the accompanying figures. However, it is to be understood that the invention may assume various alternative structures and processes and still be within the scope and meaning of this disclosure. Further, it is to be understood that any specific dimensions and/or 15 physical characteristics related to the embodiments disclosed herein are capable of modification and alteration while still remaining within the scope of the present invention and are, therefore, not intended to be limiting. The present invention relates to portable pads or slabs comprised of precast concrete or cement for use as temporary or removable foundations for industrial equipment, bulk storage tanks, cryogenic liquid pumps, heat exchangers and associated equipment such as manifolds, distillation columns, small buildings, and the like.

The use of portable or preformed structures that can readily be transferred to another 20 location and/or can be used immediately after delivery and set up is very advantageous. In certain locations permanent foundations cannot be installed and/or there is a need for a foundation that can immediately be used. In other situations, rather than purchasing and installing permanent industrial equipment and components, a business owner may choose to lease portions of equipment for a certain duration, and such equipment may be best set up on 25 a foundation, which may also be leased.

Certain suppliers will also lease expensive equipment such as a bulk storage tanks to third parties that is used in conjunction with the purchase of commodities such as liquid nitrogen and oxygen that are used and replenished on a regular basis. Due to the limited duration of the supply contracts and/or leases, it may be unfeasible for these business owners

5 to permanently install bulk storage tanks or other industrial equipment. In such a case, a foundation for the bulk storage tank or other industrial equipment is necessary, and a slab/pad that is portable and removable can be used in conjunction with the storage tank or other industrial equipment.

Additionally, business strategies as well as investment and accounting principles may

10 necessitate portable equipment and components. Supplier response time can be also be shortened; by inventorying portable pads, equipment can be installed in less time.

Portable structures are also useful in locations such as easements and leased premises where permanent structures are forbidden and the structures and equipment can be readily moved or relocated.

15 The invention contemplates a portable precast slab, with or without reinforcement, which is used as a foundation or splash pad. The slab/pad has a top surface, a bottom surface, a plurality of side surfaces, a length, a width, and a thickness, wherein the thickness varies and a weight bearing slab/pad is preferably at least about 6 inches to about 24 inches or more, and may be up to about 48 inches thick. The thickness of the pad is also important to prevent

20 the slab from breaking apart during lifting, loading, handling, use, and the like. Further, the slab is preferably at least about 6 feet in length, and may be up to about 20 feet in length. Of course in other embodiments, slabs of similar square footage ranges may also be preferable. Similarly, the slab is preferably at least about 6 feet in width, and may be up to about 12 feet in width and even wider with the ultimate limitation being portability. In an embodiment, a

25 slab of the dimensions of 10' x 15' x 16" has been especially advantageous for use as a

foundation for cryogenic storage tanks. In another embodiment, slabs of the dimensions of 10' x 15' by 6" thick, 10' x 15' by 16" thick, and 10' x 15' by 12" thick have been found to be especially desirous for use as a foundation for cryogenic storage tanks. The sixteen-inch thick slab that is 10' x 15' weighs approximately 29,250 pounds.

5 The slab can be used as a foundation for a variety of industrial equipment and/or components. The slab may be used indoors or outdoors. The invention also contemplates a portable precast slab, with or without reinforcement, which is used as a splash pad for the offloading of liquid cryogens, especially those that are flammable. Certain types of substrates such as asphalt are flammable, and the dripping of certain cryogens such as oxygen 10 onto asphalt can start a fire. In contrast, a cement or concrete surface or substrate is not flammable. As such, this invention is also directed to slabs that are used as splash pads. No special coating or films are required on the surface of the cement or concrete in order for them to be used as splash pads.

15 Of course the slabs of this invention that are used as a foundation for industrial equipment can also be used as splash pads, with or without holding industrial equipment. If the slab is to be used as only a splash pad and not as a weight bearing foundation, it does not require that the slab be of the same thickness as the slab that is used as a foundation. If for example the splash pad and foundation pad are to be placed adjacent to one another, slabs of the same thickness may be easier to install.

20 Further splash pads may be used alone or in conjunction with slabs that are used as a foundation. Just like the slabs used as a foundation, the splash pad has a top surface, a bottom surface, a plurality of side surfaces, a length, a width, and a thickness, wherein the thickness varies and is at least about 2 inches to about 48 inches, but is more preferably at least about 2 inches to 6 inches in thickness. The splash pad is preferably a minimum of 25 about 6 feet in length, and may be up to about 20 feet in length or more.

In an embodiment, the splash pad is preferably a minimum of about 6 feet in width, and may be up to about 12 feet in width or more. In a further embodiment, a preferable splash pad is of a length of about 4 feet and a width of about 8 feet. In another embodiment, the preferable splash pad is of a length of about 8 feet and a width of about 8 feet. Of course, 5 in other embodiments, splash pads of similar square footage may also be used. In all other respects, the splash pad can have the same characteristics and features of the foundation pad.

Further, the slabs/pads may have a means for attachment that allows the slab to be lifted and/or moved. The means for attachment may comprise a variety of apparatus, known to one skilled in the art such as at least one lift pin or eye loop that is accessible from the top 10 or side surfaces of the slab/pad, and that may or may not be recessed. The slab could also be designed to be moved by a forklift, or alternatively may be rigged without any specific attachment apparatus.

The slab/pad may also have a plurality of apertures that are cast into the slab and that are visible from the top or side surfaces. The apertures can be used for a variety of purposes 15 such as to hold posts or to install fence posts therein.

Further, the slab/pad may interconnect or interface with another slab or pad that may be portable or permanent. This may include at least one side surface that is shaped and/or sized to interconnect or interface with at least one side surface of another slab.

The slab/pad may have structural reinforcement. If so a variety of means known to 20 one skilled in the art may be used to reinforce the concrete or cement.

Also, if the industrial equipment comprises a bulk oxygen or hydrogen storage tank, preferably an at least 10 foot length by 10 foot width area on the top surface should be available for liquid oxygen delivery after the bulk storage tank is placed on the surface of the slab (i.e., an offloading area for the working end of a tanker truck), or a splash pad may be 25 placed adjacent to the foundation that has the same or similar width area. In an embodiment,

if the slab is used for a bulk storage tank, the slab should at least support a storage tank that is filled with at least up to about 300 to about 3000 gallons of liquid or more. Of course the pads may be used for tanks holding any other liquids and having any other function. The pads have also been used for Argon and Nitrogen tanks.

5 Just like the slabs used as a foundation and splash pads, the pads that are used for cryogenic liquid pumps or other industrial equipment have a top surface, a bottom surface, a plurality of side surfaces, a length, a width, and a thickness, wherein the thickness varies and is at least about 4 inches to about 16 inches, but is more preferably at least about 4 inches to about 10 inches in thickness. The pads used for cryogenic pumps are preferably a minimum 10 of about 6 feet in length, at least about 15 feet in length, and may be up to about 25 feet in length or more. A pad that is 8'8" x 24' by 8" thick is one such size that has been used to hold a number of high-pressure cryogenic liquid pumps. Other pads of various thickness and sizes are also contemplated for use to hold such pumps.

Because the pad/slab structure must be portable and movable, it is preferably light 15 enough so that it can be lifted by equipment that is commonly used to lift apparatuses, such as cranes and forklifts. It should also be weighted and sized so that it can be carried by a vehicle that can safely travel on roads (with or without permits) or other carriers such as boats.

This invention also contemplates a method of making and using a portable precast 20 reinforced cement or concrete slab.

As shown in **Fig. 1**, the precast slab/pad 2 has a top surface 4, a plurality of side surfaces 6, and a lower surface 8. A precast or premolded slab means a slab, pad, foundation, or foundation component that is formed by casting cement into a form or mold at a different location, prior to the time of actual use as a slab, pad, or foundation for industrial equipment. 25 The slab 2 also has a length 10, a width 12, and a thickness 14. Preferably, the slab has a Preformed Portable Concrete Slab for use as a Foundation or Splash Pad for Industrial Equipment
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thickness of at least about 6 inches to about 24 inches. The slabs that are used for foundations are preferably comprised of reinforced cement or concrete 24 and preferably have an attachment means 16, which allows the slab to be lifted. Again, splash pads may also have such attachment means.

5 Attachment means are typically employed to lift and/or move the precast slab, pad, or foundation elements. The term attachment means refers to a device or apparatus that can be incorporated into the slab that allows the slab to be moved or movable. For example, the means for attachment may essentially comprise lift pins, lift rings, lift bolts, and the like and a combination thereof that are preferably are cast steel, or other such apparatus known or
10 used by one skilled in the art for such purposes. The means for the attachment are preferably accessible from the top surface and/or side surface. The cable may be directly wrapped around or looped through the attachment means, and for example in attachment means with a loop clips, hooks and the like that is attached to cable can be inserted into or through the eye of the loop or around the other types of attachment means. According to the present
15 invention, the attachment means can also be used to secure other elements to the precast slabs, including elements from the industrial equipment such as tie down lines, ground lines, and the like used by one skilled in the art.

When installed, the top surface of the pad is horizontal with regard to the ground/substrate, and the pad should be level or substantially level. The term side surfaces
20 refer to the edges or other regions of the slabs between the top and bottom surfaces, and where a vertical side surface may begin.

The slab should be heavy enough to provide a force great enough to resist sliding and movement during wind and seismic events as well as displacement, overturning and/or sliding of the equipment such as a bulk storage tank during such events. Additional weight
25 can also be added on site, and consist of concrete, cement, or other weights, such as steel,

lead, and water. Piers, gripping members, or other methods known to one skilled in the art can be used in conjunction with the slab to resist sliding and overturning forces.

The slab should be sized such that it is capable of bearing the weight of the industrial equipment that sits upon the surface of the slab. For example, the design criteria of the 5 preferred embodiment of the slab/pad should resist moving during wind or seismic events. For example, the slab/pad should preferably withstand wind speeds of about 100 mph, such as that caused by a hurricane, and preferably should withstand seismic zone 4 conditions.

The slab/pad may comprise a unitary piece, or multiple pieces that are placed adjacent to each other that touch or abut each other. A single piece slab/pad is preferable as it is easier 10 and to set up. If a large slab is required, such as one larger than 15 feet long by 10 feet wide, or, there are weight or transportation problems, a slab comprised of multiple pieces would be more desirable. Yet, there may be disadvantages to using a slab/pad comprised of multiple pieces as it may be more difficult to level multiple pieces, the assembly may be awkward, and the pieces may come apart. Fig. 1 shows a slab/pad comprised of multiple pieces with 15 overlapping portions 9 in a stepped fashion that interface or interconnect. Alternatively, the slab/pad pieces can fit together in a variety of ways similar to puzzle pieces and may have a uniform depth at the edges with interlocking or interfitting projections and recesses, or may instead be square or rectangular pieces or other shaped pieces that abut one another. In cases where multiple pieces are used to make a slab, pad, or foundation, the side surfaces are 20 preferably the area where two pieces are joined together or placed adjacent to one another to form a pad or a slab. If so, at least on one side of the slab may have the ability to interconnect and/or interface other pads or slabs, portable or not, in order to create a larger surface. Should it become necessary to join the portable foundation to another, numerous joining means are possible that can be used to connect one slab/pad to another. Several stakes may be used 25 around the perimeter of the slab, or a frame may be installed around the perimeter of the slab

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to ensure that the slab pieces do not come apart. Alternatively, metal strap portions may be placed around the joint areas. The slab/pad of **FIG. 1** may also be comprised of a unitary piece, and would lack overlapping portions 9.

The slab/pad may be of any shape. Preferably, the slab used as a foundation will be 5 shaped and sized so that there will be a perimeter of slab left after the industrial equipment is placed on the slab. In some applications, the slab may be circular, rectangular, square, or of other shapes that will fit into the area designated for the slab. In certain applications, a certain slab area is desirable. For example, if the slab is used as foundation for a bulk storage tank, in an embodiment, at least about an 8 foot length by an 8 foot width area on the top 10 surface that is adjacent to the tank should be available for liquid oxygen delivery after the bulk storage tank is placed upon the pad or slab to comply with industry requirements for liquid oxygen systems.

The slab/pad may be made a variety of ways that are known or used by one skilled in the art. For example, concrete or cement can be poured into a form that sits on a table, 15 similar to wooden forms that are built by contractors when foundations are constructed on-site, and the table must be designed to bear the weight of the filled form. The forms may be made of plastic, wood, metal and other durable materials. The forms are preferably steel as is the table. Once the concrete or cement is cured, which typically takes about 1-2 weeks, the sides of the form are removed leaving the slab/pad sitting on the steel table. When the 20 concrete or cement dries, it pulls away from the table and the slab can be lifted off the table. Other methods of molding as well as other types of concrete or cement may be used that are known or used by one skilled in the art.

Adequate curing is essential to obtaining good quality concrete or cement and contributes to the durability and the wear resistance of the slab/pad. During the curing 25 process, the concrete or cement should not dry out prematurely, but should retain moisture. Preformed Portable Concrete Slab for use as a Foundation or Splash Pad for Industrial Equipment
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and gradually dry in order to build up strength and gain durability and wear resistance. The amount of time required to cure will depend upon the size and thickness of the slab pieces as well as type of concrete or cement used. To slow the drying, the slab/pad can be covered with plastic sheeting after the mold is filled. Alternatively, a commercial curing compound 5 may be sprayed, brushed or rolled onto the surface of the concrete or cement. Also, for example, a water-reducing admixture such as one that meets ASTM C494 standards may also be mixed into the concrete or cement. Further, it is preferable that calcium chloride admixtures be avoided.

In an embodiment, the bottom of the slab/pad is concrete or cement. Of course the 10 plates or other apparatuses may also be attached or joined to the bottom of the slab/pad. For example to increase friction between the soil and the foundation or to grip the substrate, rebar or other metal or other materials that are rigid or semirigid could be could be molded into or otherwise attached the bottom of the concrete or cement pad/slab.

The cement that is used is preferably conventional cement, such as Portland cement, 15 ASTM C 150, Type 1. The concrete that is used is preferably conventional concrete, such as Portland cement, ASTM C 150, Type 1, which has an ultimate compressive strength of at least about 2000 psi, and preferably to about 4000 psi. Of course, high strength concrete could also be used for at least a portion of the slab/pad. The maximum water cement ratio is preferably about 0.45, with normal weight aggregate such as ASTM C33, with preferably no 20 more than about 5% voids in the concrete. Other aggregates, and criteria that are known or used by one skilled in the art can also be used with respect to the choice of concrete or cement, aggregate, and percentage of voids in the concrete or cement. Depending upon the weight requirements, a portion of lightweight concrete or cement may also be used to form the slab/pad.

Varying densities of concrete or cement can also be used to increase the stability of the slab. For example, higher density concrete or cement may be used in certain areas, such as the perimeter and edges, with lighter weight concrete or cement in locations such as the center. Also the slab/pad can be weighted such as at the edges to increase the stability of the 5 slab/pad.

For durability, the concrete or cement is preferably reinforced. For example, a plurality of wires, rebars, rods, bars, plates, gravel, glass, glass fibers, or carbon fibers and a combination thereof can be used as a reinforcing means and are cast into the concrete or cement. Bars or rods 22, and rebars 26 such as those made from metal, fiberglass, or 10 polymers or a combination thereof are preferably used to reinforce the concrete or cement slab. See Fig. 1. Rebars are the most preferable.

In an embodiment, the preferable rebar comply with ASTM A 615 specification, and are grade 60 bars. Other standards known or used by one skilled in the art may also be used. If the bars are bent or deformed, they are preferably bent or deformed while cold. Further, 15 the rebar or rods may also be formed into a support frame, and if desired, the means for attachment can be is removably or securely attached to the support frame, rebar, or rods. Preferably, there is at least a 2-inch to 3-inch thickness of concrete or cement that covers the rebars, bars, or rods, or plates. If glass, gravel, pebbles, broken stone, slag, or carbon fibers are chosen, they are preferably interspersed throughout the concrete or cement. See e.g. Fig. 20 8. The rebars or rods are placed in the form at the time of casting and act to strengthen the slab after the slab has cured.

Preferably, conventional rebar 26, such as ASTM A36 steel is used. The rebars may be arranged and spaced in a variety of ways. Preferably, the rebars or rods are no more than about 3 feet apart, and are preferably about 12 inches to about 18 inches on center with 25 respect to each other. Also, the rebars are preferably at least about #3 to about #10 rebar

which is equivalent to about 3/8 inch in diameter to about 1-1/4 inches in diameter or more. Of course, rebar of a greater diameter can also be used. Further, the rebars may be parallel to one another and are preferably further criss-crossed. The rebar may be one layer thick, made into a 3 dimensional support frame, or instead two layers or more of rebars can be used. For 5 example, in an embodiment, the top rebars can be #5 or 5/8 rebar in diameter, are criss-crossed, and are spaced about 16 inches each way, while the bottom rebars are # 8 rebar or 1 inch in diameter and are criss-crossed with spacing about 12 inches to about 18 inches on center from each rebar. Further, when two layers are used and the rebar is criss-crossed, the rebar may be staggered and spaced such that rebar is present about every 6 inches to about 10 every 8 inches.

If the slab/pad is such a length that extensions must be used to splice the rebars to each other, the rebar is preferably overlapped at the spliced areas 27, such as in accordance with ACI 318, and preferably not less than 40 bar diameter, not less than about 1 inch to about 6 inches of rebar in the lapped area. See e.g., Fig. 7A. Other criteria known or used by 15 one skilled in the art may also suffice. The rebars or rods can also be prestressed prior to molding, if desired. Prestressed refers to an object that is stretched and stressed prior to being molded in the slab.

Because the slab is portable, it preferably has a means of attachment that allows the slab to be moved and/or lifted, such as by a cable. The term cable refers to a line, strand, or 20 chain or other such devices known or used by one skilled in the art that are which may be attached or connected to the attachment means. A variety of apparatuses can be incorporated into the slab/pad that allows the slab/pad to be moved. For example, the means for attachment may comprise lift pins or lift rings that are preferably are cast steel, or other such apparatus known or used by one skilled in the art and are preferably accessible on and from 25 the top or side surface. Fig. 3 is a cross-section of a lift pin that is removably attachable to

the slab. The pin 30 is steel and has an enlarged head 32 that allows cable 40 to be wrapped around the head, and has a threaded end 34 that is insertable into corresponding threads 36 in a metal housing 38. Fig. 3, shows the use of gravel 39 in a cement matrix 40. Mortar could also be used. Of course the concrete may also be comprised of cement or mortar with 5 pebbles, broken stone, or slag.

If the lift pin or other attachment means are accessible from the top, they are preferably perpendicular to the top surface of the slab. If they are accessible from the side surface, they are preferably perpendicular to the side surface(s). One such lifting pin is supplied by Jenson Pre-Cast, and is an 8-ton lift pin. Preferably, the lift pins do not extend 10 beyond the top surface of the concrete or cement. In an embodiment, attachments known as "knuckles" are attached to embedded lift pins, and cables are attached to the "knuckles".

Lift pins are also sold by other companies such as Conac, and come in varying strengths ranging from at least about 1 ton to about 26 tons. The required strength of the lift pin will depend upon weight, thickness, and size of the slab/pad or other such factors known 15 or used by one skilled in the art. Fig. 4 shows an attachment means that has a looped end 42 that protrudes from the top surface 4 of the slab 2 that is embedded in the 24 slab. The eye loop allows for cable hooks to be inserted into the eye 44 of the loop. Preferably, the attachment means do not protrude from the surface, and are preferably recessed as in Fig. 7C. The eyebolt may be threaded on one end and looped on the other end. Fig. 7B and 7C shows 20 a further embodiment of an attachment means that is a pin 50 having an enlarged end 52 at both the surface of the slab and the end that is embedded into the slab. Also, the pin may be located in a recessed surface 5 of the slab so that it does not protrude above the top surface of the slab. This can be accomplished by placing a cap on top of the pin to create the void at the top of the lifting pin. As a further alternative, Fig. 8 shows an anchor bolt 54 with similar 25 stress and weight bearing capabilities that has an enlarged end 58 that allows cables to be

attached thereto. The anchor bolt may be embedded directly into the concrete or cement, such as at a depth of 12 inches 56.

If the attachment means such as a lift pin or bolt is not attached to the rebar, it is preferable to embed the attachment means at least about one-half to about three-fourths of the 5 width of the slab so that the attachment means will not pull out of the slab when the slab is lifted and/or lowered by attaching cables and the like to the attachment means.

All of the foregoing pins and attachment means are preferably placed within the form before the concrete or cement is poured into the form or mold and/or before the concrete or cement begins to dry. However, the attachment means may also be installed after the 10 concrete or cement is cured. For example, a hole could be drilled through the pad and a rod with a hook or eyelet with a bottom plate would be installed. Also the holes may be filled with epoxy after the attachment means is inserted.

The attachment means should be placed at a certain depth that precludes them from pulling out of the concrete or cement, such as a depth of at least about 4 to about 8 inches to 15 about 12 inches to 14 inches or more. Of course the depth will be limited by the thickness of the slab. The slab when used as a foundation is preferably at least about 1 foot thick to about 4 feet thick, depending upon the specific use. For example, in a slab that is 16 inches thick, the attachment means such as a pin is preferably inserted to a depth of about 12 inches.

Alternatively, the embedded end of the attachment means may be attached to the rebar, such 20 as by wrapping the embedded end of the attachment means around the rebar or otherwise securely or removably attaching the attachment means to the rebar.

Depending upon the size and thickness of the slab, one or multiple means for attachment may be used. The number and spacing of the means for attachment should be apparent to one skilled in the art and will depend upon the strength of the attachment means 25 as compared to the weight and size of the slab so that stresses do not break the means for

attachment or cause the attachment means to pull out of the slab. For example, in **Fig.1**, there is only one means for attachment 16 that is located at or near the center of each slab 2. In contrast, the slab 2 of **Fig. 5** has a plurality of separate means for attachment, and in an embodiment that is 10 feet width by 15 feet length and 16 inches thick, three to four 8-ton lift 5 pins are used. In any case, the means for attachment should be spaced and located so that the slab will be approximately level and easy to control when it is moved and placed upon the ground or other substrate.

The substrate 18 such as asphalt or ground upon which the slab is placed is preferably level prior to placing the slab on the substrate or ground. See **Fig. 7A**. If the surface is not 10 level, the surface will preferably be leveled by a layer not more than about $\frac{1}{2}$ inch depth to about 1 foot depth of about $\frac{1}{4}$ inch to about $\frac{1}{2}$ inch, or more size angular aggregate below the pad, such as by Air Liquide America. Alternatively, the slab can be leveled after it is placed upon the substrate or ground. For stability, it is preferable that the slab not be installed on 15 wet or soft soil. To ensure stability, the preferable allowable soil bearing pressure is at least about 1000 psf (pounds per square foot). Also, preferably, there will be positive drainage from the substrate.

After the slab is installed, there is no waiting for the slab to dry as it is already dried and cured prior to moving the slab. Therefore the slab can immediately be used as a foundation for industrial equipment 66 such as a bulk storage tank 64 that can be placed 20 directly upon the top surface of the slab. See **Figs. 5, 7A**. Any equipment can be placed upon the slab as long as the slab meets the seismic load demands of the equipment, as determined by a structural engineer or other person skilled in the art.

Further, if the slab is used to support a storage tank that is placed upon the top surface, the additional weight from the stored liquid must be taken into account with respect

to the size and thickness of the slab. For example, in an embodiment, for a slab that is 15 foot long by 10 foot wide slab, and 16 inches thick, the storage tank can be filled with up to about 1500 to about 3000 gallons of liquid oxygen. The weight of a storage tank with about 1500 gallons of liquid is about 28,100 pounds, and a storage tank with about 3000 gallons of 5 liquid is about 47,000 pounds.

If it is desirable to install fencing around the perimeter of the slab and/or the industrial equipment, multiple apertures 70 which can hold fence posts can be incorporated, into the slab, such as by molding or drilled into the molded slab. See **Fig. 5**. The apertures 70 may comprise blind holes that extend part way through the depth of the slab, or may comprise 10 holes that extend through the thickness of the slab. See **Figs. 6, 7A**. The holes may be of a diameter that is sufficient to receive fence posts. For example 4-inch diameter holes are used to receive 3-inch diameter fence posts that are installed in the field. To create the holes, 4-inch PVC capped pipe is placed in the mold/form before the concrete or cement is poured. The PVC pipes create the multiple 4-inch diameter voids. At a minimum, it is preferable to 15 provide holes at least in every corner of a rectangular or square slab. It may also be advantageous to provide additional holes for the fence posts 7. For example, in a 15 foot long by 10 foot wide slab that holds a bulk storage tank or vessel 64, it has been determined that at least nine holes should be molded into the slab.

The slab must preferably also adequately drain. In most circumstances, a flat slab will 20 adequately drain. As an alternative, the slab may further have a plurality of furrows 75 in the top surface of the slab to ensure drainage of water from the slab. See **Fig. 5**. Furrows may be incorporated by pressing a form into at least a portion of the top surface of the concrete or cement, which has not hardened, or the furrows may be made by other ways known to one skilled in the art. However, the furrows should be strategically located so that they do not

cause the top surface of the slab to be unlevel. Further, the concrete or cement may be finished by a broom before it hardens so that the top surface is not slick.

In an embodiment, a vessel leg plate 62 of the vessel leg 66, such as for a bulk storage tank, is also anchored to the slab, such as by an anchor bolt and epoxy. In an embodiment, a

5 hole of a diameter of approximately $\frac{3}{4}$ " to about $1 \frac{1}{2}$ " that may extend as deep as the thickness of the slab is drilled into the slab and/or vessel leg plate at the desired position, then an epoxy pack is inserted and is ruptured by the bolt, mixing the epoxy portions together. A

nut may then be installed upon the bolt to further secure the leg plate, which is accessible through a portion of the vessel leg that is typically open. For example, Hilti supplies such

10 epoxies and anchor bolts, and other such adhesives and fasteners are also commercially available. Of course other such methods of securing the vessel leg and leg plate known to

one skilled in the art may also be used. In an embodiment, a layer of grout 60 may also be used between the vessel plate and the top surface 4 of the slab. The legs or portions of other types of industrial equipment may also be secured to the slab.

15 Again, a method of using a portable precast slab as a foundation for industrial equipment is contemplated comprises: providing a portable precast slab that has a top surface, a plurality of side surfaces, a lower surface, a length, a width, and a thickness. During use, the lower surface of the slab is placed on ground, and the level of the slab is checked and/or the slab is leveled. Next, at least one piece of industrial equipment can be placed on the top

20 surface of the slab.

The method also contemplates the step of casting reinforcing means into the concrete or cement, wherein the reinforcing means is selected from the group consisting essentially of wires, rebars, rods, bars, plates, gravel, glass, or carbon fibers or a combination thereof.

The method also comprises the step of providing means for moving or lifting the slab

25 that is accessible from the top surface or side surface of the slab. The means for lifting or

moving may be selected from the group consisting essentially of at least one lift pin, at least one lift ring, at least one lift bolt, an anchor bolt, and a combination thereof. The means for attachment may be securely attached or removably attachable. Also, the method further comprises the step of attaching a cable to the lifting means and lifting the slab.

5 In this method, for example, the industrial equipment may comprise a bulk storage tank. If so, it may be desirable to provide a slab that has at least a 10-foot length by a 10-foot width area on the top surface adjacent to the tank that is available for liquid oxygen delivery after the bulk storage tank is placed on the top surface of the slab.

10 The slab may comprise multiple pieces and the pieces may be placed adjacent to each other to form the slab.

Further in this method, fencing may be installed around the perimeter of the slab and/or the industrial equipment.

Also this method may further comprise the step of using at least a portion of the slab as a splash pad.

15 A method is also contemplated for making a precast reinforced slab that is used as a foundation for at least one bulk storage tank or system that comprises providing a mold or form, at least partially filling the mold with concrete and placing at least one rebar or rod within the concrete or cement to reinforce the concrete or cement, wherein at least one rebar or rod has at least one lift pin or means for attachment that is integral with or removably attached to the at least one rebar. Next, the rebars or rods are covered with concrete or cement.

20 Then, the concrete or cement is allowed to dry and/or cure, thereby forming a slab/pad, wherein the slab/pad has a top surface, a bottom surface, a plurality of side surfaces, a length, a width, and a thickness. The slab is removed from the form when the slab is at least partially dried. In this method, there may also be a plurality of apertures that are cast

into the slab that are visible from the top surface. The apertures have a variety of uses and for example can be used to install fence posts therein.

In this method, the mold or form provides at least one side surface shaped so that the slab is capable of interconnecting or interfacing with at least one side surface of another slab.

5 Further, in this method, a plurality of rebars or rods are used as a reinforcing means, and the rebar is placed parallel to one another and/or in a criss-cross fashion.

Further, where a plurality of rebars or rods are used as a reinforcing means, the rebars or rods are arranged to form a three-dimensional support structure that is cast into the concrete or cement. Also in this method, the rebar or rod may be prestressed prior to molding.

In this method, the slab is dried and/or cured prior to use.

In this method, at least a portion of lightweight concrete or cement or other materials designed to reduce the weight of the preformed pad may be used to form the slab.

Further, as part of this method, a plurality of furrows may be made in the top surface of the slab to ensure drainage of water from the top surface of the slab.

Additionally, if the pad is used as a foundation for a bulk storage tank, the slab preferably has at least a 10-foot width by 10-foot length area on the top surface that will be available for liquid oxygen delivery after the bulk storage tank is placed on the top surface of the slab.

20 It is noted that the methods and embodiment of apparatus described herein in detail
for exemplary purposes is of course subject to many different variations in structure, design,
application and methodology. Because many varying and different embodiments may be
made within the scope of the inventive concept(s) herein taught, and because many
modifications may be made in the embodiment herein detailed in accordance with the

descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

Further, it will be understood that many additional changes in the details, materials, steps and arrangement of parts, which have been herein described and illustrated in order to
5 explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims. Thus, the present invention is not intended to be limited to the specific embodiments in the examples given above and/or the attached drawings.